

EFFECT OF CHEMICAL PRIMING ON THE GERMINATION OF BJRI MESTA 2 (*Hibiscus sabdariffa*) UNDER SALINITY

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ABSTRACT

In the present research, the impact of chemical priming on BJRI Mesta 2 (*Hibiscus sabdariffa*) germination under salinity stress was examined. The seeds were primed with KNO₃ (10mM), GA₃ (50mM), or H₃BO₃ (8μM) then tested with NaCl concentrations ranging from 0 to 200mM. The findings indicated that germination significantly decreased as salinity increased, reaching total suppression at 200mM NaCl. Salinity effects were lessened by chemical priming; KNO₃ was the most successful, retaining 83.3% germination at 0mM and 5.0% at 200mM, followed by GA₃ and H₃BO₃. KNO₃ is superior at promoting germination under stress. The results provide information for growing BJRI Mesta 2 in areas impacted by salinity and demonstrate the ability of chemical priming, especially KNO₃, to enhance seed germination in saline circumstances.

Key words: Boric acid, gibberellic acid, potassium nitrate, sodium chloride, salt stress

Introduction

Salinity reduces the proportion of seeds that germinate and delays the onset of the germination activity. At salinities over the species' tolerance confines, the process of germination may completely stop due to a variety of factors, including inadequate imbibition, ionic toxicity, metabolic disruption enzyme devastation, and growth regulator instability (Imam *et al.*, 2022). By either creating an external osmotic potential that prevents water intake or by negatively affecting the growing seeds through the action of salt ions, salinity in the soil can influence how seeds germinate (Mostafa *et al.*, 2022). Among the effects of severe salinity on plants are water stress, ion toxicity, nutritive issues, modifications to metabolic method, membrane disarray, reduced cell enlargement, and genetic toxicity. All of these effects work against plants' ability to grow, establish, and survive (Chakraborty *et al.*, 2020). Abiotic stresses such as salt, drought and temperature extremes can significantly affect the growth and development of plants (Mansour *et al.*, 2022). The present investigation sought to accomplish the following two goals: (i) examine whether salinity effect inhibits or does not inhibit the germination and (ii) determine the appropriate pre-treatment that enhances germination and counteracts the effects of NaCl by examining the role of KNO₃, GA₃, and H₃BO₃ during the germination of BJRI Mesta 2 (*Hibiscus sabdariffa*) under increasing salt levels.

Materials and Methods

Seeds of BJRI Mesta 2 (*Hibiscus sabdariffa*) were collected from Jute Seed Production and Research Centre, Nashipur a locality close to Chehelgazi, Dinajpur Sadar, Rangpur Division, Bangladesh (25° 43' 15" N, 88° 39' 54" E). After being taken out of the pod, they were kept dry at 20 °C. They were cleaned five times with sterile water after being sterilized for five minutes with 70% ethanol. The seeds were kept in fully wrapped 9 centre meter Petri plates using Whatman paper #1 moistened with 2 millilitres of ultra-pure water. 3 replicates of 20 seeds were examined for each treatment. To find out how many seeds had sprouted, the plates were examined daily for seven days. The seeds were considered to have germinated if they formed radicals longer than 1 mm. To test the ability of the seedlings to tolerate salinity, seeds were

sown in Petri-dish on filter paper saturated in (0mM, 50mM, 100mM, 150mM, and 200mM) NaCl salt solution. The control seeds received continuous applications of distilled water. To improve germination under rising NaCl concentrations, BJRI Mesta 2 seeds were soaked for four hours in three distinct chemical treatments. Following a thorough cleaning with ultra-pure water, they were dried and kept in a seed germinator at 25°C to germinate. The effects of external delivery of KNO₃ (10mM), GA₃ (50mM), and H₃BO₃ (8μM) on germination were investigated using a variety of NaCl concentrations (0mM, 50mM, 100mM, 150mM and 200 mM). These priming chemical concentrations were chosen based on preliminary experimental results (data not provided).

Data Analysis: For this experiment, germination percentages were count by the following formula that is given below:

$$\text{Germination (\%)} = (\text{Number of germinated Seeds} / \text{numbers of sample seeds}) \times 100.$$

The data were subjected to one-way analysis of variance (ANOVA) to evaluate the effect of the salinity and their interactions on the germination percentage. Tukey's test was carried out to perform all- pairwise comparisons between the individual treatment ($p < 0.05$). All statistical analysis was performed using RStudio 4.5.0 software.

Results and Discussion

Effect of different concentration NaCl salt solution on seed germination of BJRI Mesta 2

The effect of different concentrations of NaCl salt solution on the germination percentage of BJRI Mesta 2 seeds revealed that as NaCl concentration increases, seed germination significantly decreases. At 0mM (control), the germination rate is highest at 76.7%, with a standard error (SE) of ± 1.7 . As salinity increases to 50mM and 100mM, germination drops to 66.7% and 53.3%, respectively, both with SE ± 1.7 . At 150mM, a sharp decline is observed, with germination at only 20.0% (SE ± 2.9), and at 200mM, germination ceases entirely (0.0%, SE ± 0.0). The results indicate a strong inverse relationship between NaCl concentration and seed germination, suggesting high sensitivity of BJRI Mesta 2 to salinity stress. At 0mM (control), germination was highest (76.7%), while complete inhibition (0%) occurred at 200mM NaCl (Fig. 1). This pronounced decline highlights the strong sensitivity of *H. sabdariffa* to salt stress, likely due to osmotic and ionic imbalances that disrupt water uptake and cellular metabolism during germination (Shahid *et al.*, 2020; Atta *et al.*, 2023).

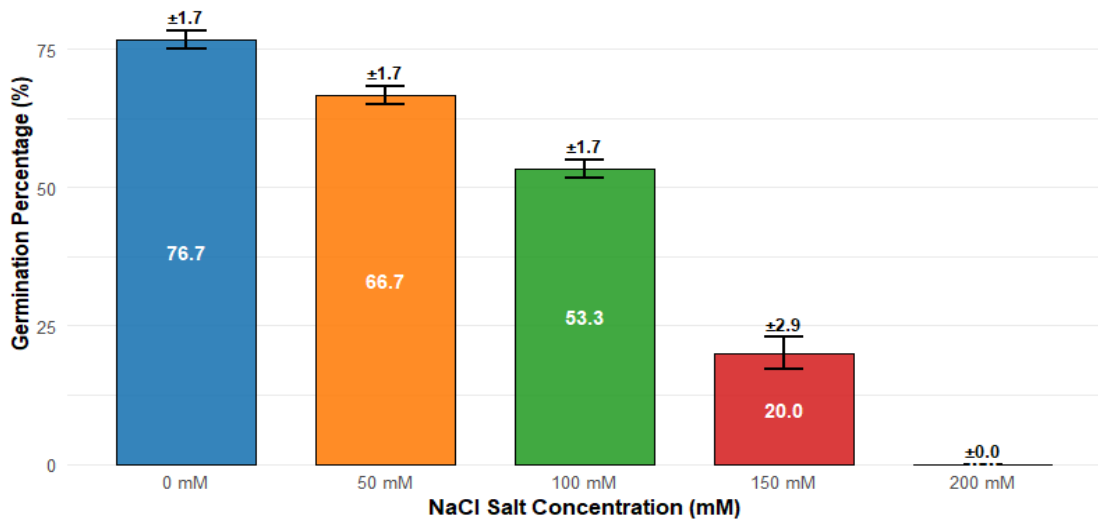


Fig. 1. Effect of different concentration of NaCl solution on germination of BJRI Mesta 2

Comparable reductions in germination have been observed in *Hibiscus sabdariffa* under saline conditions by Taghvaei *et al.* (2022), who reported severe inhibition above 150mM NaCl. Similarly, Ali *et al.* (2021) demonstrated that salinity above 100mM negatively affects germination across glycophytic species, including okra and cotton, due to the accumulation of Na⁺ and Cl⁻ ions that hinder radicle protrusion and enzymatic activity. Studies in rice and barley also confirm that high salinity alters hormonal signaling, delaying embryo growth and reducing seedling vigor (Nawaz *et al.*, 2020).

Effect of chemical priming on seed germination of BJRI Mesta 2 under salinity

At all salinity levels (0 to 200mM), KNO₃-primed seeds consistently exhibit the highest germination percentages, followed closely by GA₃, with H₃BO₃ showing the lowest performance. For instance, at 0mM, KNO₃ yields 83.3% germination, higher than GA₃ (80.0%) and H₃BO₃ (76.7%). This trend continues at 50mM (KNO₃: 73.3%, GA₃: 71.7%, H₃BO₃: 66.7%) and 100mM (KNO₃: 61.7%, GA₃: 56.7%, H₃BO₃: 53.3%).

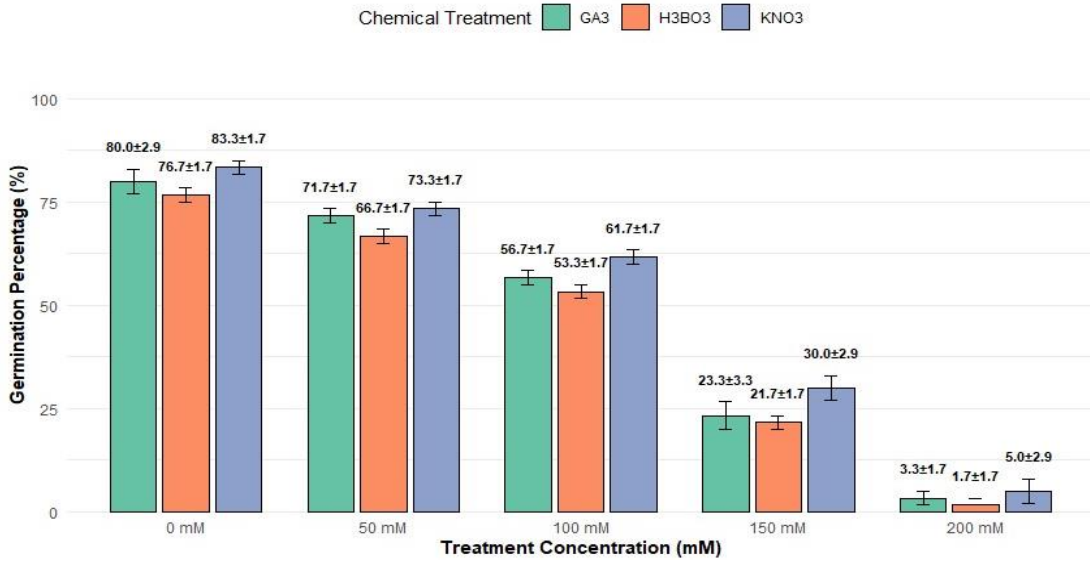


Fig. 2. Effect of different chemical priming (KNO₃, GA₃ and H₃BO₃) on germination of BJRI Mesta 2

The differences become more pronounced under higher salinity, with KNO₃ maintaining relatively better germination at 150mM (30.0%) and 200mM (5.0%), compared to GA₃ (23.3%, 3.3%) and H₃BO₃ (21.7%, 1.7%). Overall, KNO₃ demonstrates superior protective effects against salt stress, suggesting it is the most effective priming agent among the three, while H₃BO₃ is the least effective (Fig. 2). Similarly, GA₃-primed seeds showed high germination at 0mM (80.0%±2.9) and 50mM (71.7%±1.7), but germination decreased to 56.7%±1.7 at 100mM and dropped sharply to 23.3% ± 3.3 at 150mM, eventually reaching 3.3%±1.7 at 200mM. While GA₃ maintains relatively strong germination at lower salinity levels, its effectiveness decreases rapidly as salinity intensifies. Compared to KNO₃, GA₃ appears to offer slightly less resilience at the highest salt concentrations, though both show similar overall trends. In the case of H₃BO₃ priming, germination was lowest across nearly all concentrations when compared to the other two treatments. Starting at 76.7% ± 1.7 at 0mM, germination declined to 66.7% ± 1.7 at 50mM, and further dropped to 53.3% ± 1.7 at 100 mM. The decline became steeper at higher salinities, with only 21.7%±1.7 at 150mM and a mere 1.7%±1.7 at 200mM. These results indicate that H₃BO₃ offers the least protection against salinity-induced stress during germination. Overall, while all priming agents improve germination under lower salt concentrations compared to non-primed seeds, KNO₃ appears to be the most effective, followed by GA₃ and then H₃BO₃.

Effect of individual chemical priming on seed germination of BJRI Mesta 2 under salinity

Seed priming treatments with GA₃, H₃BO₃, and KNO₃ significantly enhanced germination compared to non-primed seeds under saline conditions, with the effectiveness ranking as KNO₃>GA₃>H₃BO₃. KNO₃-primed seeds maintained higher germination percentages across all NaCl levels, particularly at 150mM (30%) and 200mM (5%), indicating its strong protective potential. The superiority of KNO₃ priming has been confirmed in several studies, where nitrate acts as both an osmotic regulator and signalling molecule that enhances antioxidant activity and ion balance under salinity (Rehman *et al.*, 2024; Zhang *et al.*, 2022). KNO₃ also promotes ROS scavenging and regulates the K⁺/Na⁺ ratio, enabling better germination and early seedling establishment (Iqbal *et al.*, 2019).

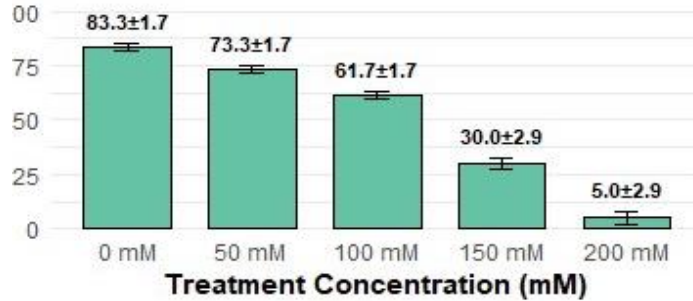


Fig. 3. Effect of KNO₃ on germination percentage of BJRI Mesta 2

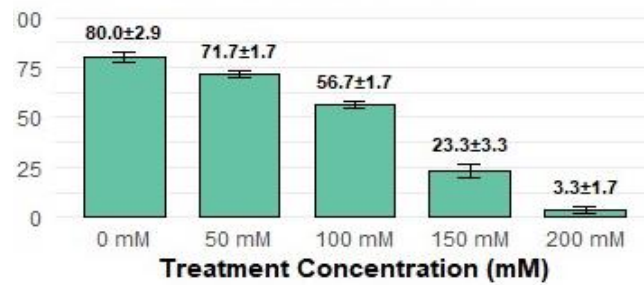


Fig. 4. Effect of GA₃ on germination percentage of BJRI Mesta 2

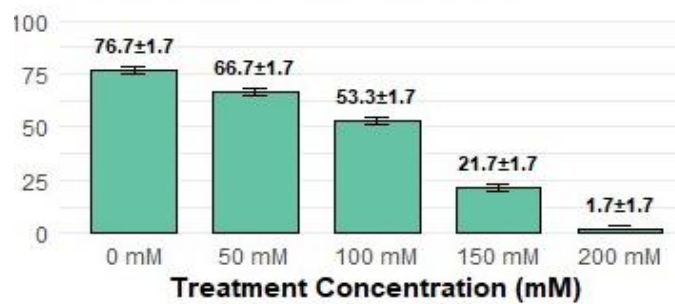


Fig. 5. Effect of H₃BO₃ on germination percentage of BJRI Mesta 2

Similarly, GA₃ priming improved germination at moderate salinity (up to 100mM) but its effectiveness decreased sharply under severe salt stress (Fig. 4). This trend supports the findings of Farooq *et al.* (2022), who observed that GA₃ enhances α-amylase activity and starch mobilization during early germination but

fails to overcome extreme osmotic stress. In contrast, H_3BO_3 priming produced the lowest germination percentages, aligning with previous findings that boron has limited influence on osmotic adjustment and antioxidant activation under salinity (Fig. 5). Similar patterns were observed in *Capsicum annuum* and *Gossypium hirsutum*, where KNO_3 priming significantly outperformed boron or hormonal priming in maintaining seed viability under salt stress (Hussain *et al.*, 2023). Overall, the results of the present study confirm that KNO_3 priming is the most effective treatment for enhancing salt tolerance in *H. sabdariffa* seeds, primarily through osmotic balance, ion homeostasis, and improved metabolic recovery during germination.

Conclusion

It is so clear from the present investigation that salinity has a direct effect on germination of BJRI Mesta 2 (*Hibiscus sabdariffa*). But chemical priming improves germination process without reducing the saline concentration. Moreover, future studies need to assess germination and early seedling growth at the field condition.

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Author's contributions

M. A. R. Taohidi and M. Khatun: conceptualization, methodology, validation, data analysis, M. A. Hasan, M. W. Islam, S. Mitra: reviewing, editing and final editing. All authors reviewed the findings and accepted the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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